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ABSTRACT

Four studies examined the relationship between students' ability and the learning processes the students engaged in when they acquired knowledge from their classroom experiences. The research was based on a model of learning processes during knowledge acquisition that identifies critical learning experiences and predicts what is learned and remembered. Each study involved detailed observation and audio and video recording of classroom experiences of selected upper primary or intermediate students during a science or social studies unit, as well as individual student interviews. Student learning measures were administered several weeks before and after the unit and again 12 months later. Findings indicated that the model predicted the learning of 86 percent of items whose content was learned and predicted failure to learn for 80 percent of items that were not learned. The lowest prediction rates were for students in the mid-range of ability, with no indication that the learning process was different for the most and least able. Patterns of correlations suggested that although student ability was related to prior knowledge levels, there was no relationship between prior knowledge level and amount learned during the unit. If the appropriate number of learning experiences occurred, without significant gaps between them, learning occurred regardless of students' ability level. Academically relevant discussions were more likely when there was a social climate of acceptance and valuing of each other's ideas, which was more likely with more able students. The major factors affecting whether students access learning opportunities appeared to be related to culture. (Contains 23 references.) (Author/KB)

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What role does ability play in classroom learning?

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What role does ability play in classroom learning?

This paper is about the relationship between students' ability and the learning processes they engage in when they acquire knowledge from their classroom experiences. For a number of years, Adrienne Alton-Lee and I have been involved in a series of studies of students' learning in classrooms in which we have analysed the details of individual students' classroom experiences throughout the course of units in science and social studies and related those experiences to measures of the students' learning of the intended content (cf. Alton-Lee & Nuthall, 1990; Alton-Lee & Nuthall, 1992; Alton-Lee, Nuthall & Patrick, 1993; Nuthall & Alton-Lee, 1992; Nuthall & Alton-Lee, 1993; Nuthall & Alton-Lee, 1995). In these studies we have developed a model of the learning processes involved in knowledge acquisition that has allowed us to identify critical learning experiences and to predict from the content, sequence and timing of these experiences exactly what students will and will not learn and remember. (Nuthall & Alton-Lee, 1993; Nuthall & Alton-Lee, 1994)

An important characteristic of this model of the learning process is that we have not found it necessary to take any account of student ability. The acquisition of knowledge that takes place as a consequence of classroom experiences in typical science and social studies units in upper primary and intermediate school classes seems to be dependent on the nature, frequency and timing of those experiences, but not on the ability of the students. In other words, students whose percentile scores on school-administered PAT tests indicate very high levels of ability appear to learn in exactly the same way as students whose percentile scores are relatively low.

Ability, as it is represented in norm-referenced scores on standardised tests of scholastic aptitude and attainment, is a common part of our thinking about student learning. Almost without exception, scores on such standardised tests predict success in both the informal and formal (e.g. public examination) measures of school learning. There is every reason to believe, on the basis of research, that scores on these tests represent genuine underlying differences in ability between students, and that these underlying differences in ability determine how well students learn from

their classroom experience. It is for this reason that scores on PAT tests accompany students through their upper primary, intermediate and early high school years. Teachers use them to make judgements about potential academic achievement, and for making decisions about grouping and streaming within and between classes. Students with high PAT scores are expected to do well in almost all aspects of their schooling. Students with low PAT scores are not expected to do well, and are treated accordingly.

Common sense would suggest that students with different levels of ability would learn in different ways. For example, low ability students are said to be 'slow learners'. They are expected to take longer, or need more experiences, than more able students. More able students are said to learn more quickly. They need less time, or fewer experiences in order to learn. Alternatively, low ability students are believed to have more difficulty understanding what they are taught. They need simpler or more detailed explanations. Teachers' explanations and classroom materials that target middle ability students are though to be too difficult for low ability students to understand. They require simpler materials or simpler or more frequently repeated explanations before they understand and consequently learn.

Our data indicate that there are considerable individual differences between students in what they learn and do not learn in the same classroom contexts. These differences are produced by differences in what they already know, and by differences in the way they access or create learning opportunities in the classroom. The purpose of this paper is to look more closely at these individual differences in learning experiences and to identify ways they might be related to differences in ability (as these are represented in PAT test percentile scores). If there are no differences in the ways more and less able students learn, what is it about their classroom experiences that result in the more able students learning more and the less able students learning less?

Related research.

There appears to be no classroom based research to support the widely held belief that low ability students learn differently from high ability students. Studies of streaming suggest that students in high ability classes or groups learn more because they are taught more and taught at a higher level than

students in low ability classes (cf. Oakes, 1992). There is also research that compares the classroom behaviours of more and less able students, but this research is based on the assumption that any such differences are the result of differences in ability and not the cause. We take it for granted that ability is the independent, not the dependent variable, and that differences in behaviour reflect differences in the way more and less able students learn.

Much of the classroom behaviour research has been undertaken on students in co-operative groups in classrooms. A major concern of those advocating the use of co-operative groups has been to identify the best mix of students to put into such groups (cf. Cohen, 1994). Common sense suggests that putting more able students in the same group as less able students will limit the progress of the more able students. Similarly having groups composed entirely of less able students will result in very slow progress.

In a study designed to identify differences in the behaviour of students in same-ability and different-ability groups, Jones and Carter (1994) found that when low ability students were put together in pairs to work on science problems, their progress was limited in a number of ways. They took longer to follow the teacher's instructions and spent more time organizing and preparing the relevant materials. They did not seem less concerned with achieving success but focused more on the details of the activity rather than its academic purpose.

> They did not discuss patterns [in the results] or give any indication that there might be more to the task than finishing the worksheet. ... She [Lisa] realised she had marked the wrong answer on her paper [worksheet] and she was very concerned. Lisa spent quite a bit of time and effort worrying about how to fix her answer. (Jones & Carter, 1994, p.608)

This lack of awareness of the academic purpose of tasks, and concentration on the more academically peripheral aspects of tasks (such as drawing headings, ruling lines, getting worksheets finished neatly and quickly) has also been noted by Anderson (1984). She found that lower ability students in particular had very little understanding of the academic purposes of classroom activities and consequently no understanding of why they were rewarded (or not rewarded) for their work.

Jones and Carter also noted that low ability pairs of students lost interest or involvement in the task more quickly and were more likely to disrupt and ridicule each other's behaviour. Frustration with doing the tasks often erupted into interpersonal conflict.

Lisa: It's going to be the same way.
Linda: No, it won't.
Lisa: You think you know everything.
Linda: I know.
Lisa: You don't.
Linda: 'Cause see, watch. Ha, ha, yours won't balance.
Lisa: Yeah, I know why yours balanced, because you copied.
(Jones & Carter, 1994, p.609)

High ability students were more likely to interact in co-operative and mutually supportive ways, were more likely to focus on the academic purpose of the task, showing curiosity and a concern for knowing that took them further into the content than the task required. Less time was wasted because of their confidence that they knew what to do and how to do it.

A similar pattern of results was found by Bennett & Desforges (1988) in their study of the extent to which teachers matched the difficulty of tasks to the ability levels of students.

> Low attainers produced very little work, concentrated on the production aspects of tasks, were slow to start, made extensive demands on the teacher and consequently spent considerable time waiting for help. (Bennett & Desforges, 1988, p. 227)

They also noted that the low ability students were industrious and concerned with producing the best work they could. However, teachers emphasized procedural aspects of tasks (layout, neatness, writing the date, and following routines) and so long as the low ability students focused their efforts on these requirements, they were praised by the teachers.

Bennett and Desforges interpreted their data to mean that the difficulties and problems experienced by less able students were the product of the mismatch between the difficulty level of the task and the students' ability. Lowering the difficulty level of the tasks would have resolved these problems.

One recent study raises doubt about the underlying role of student ability as a cause of differences in classroom behaviour. Forman and Larreamendy-Joerns (1995) studied the effects of putting together students with different levels of ability in collaborative problem-solving groups. What they expected to find was that the high ability students would assist the low ability students to reach a higher level of performance. What they did find was that the students would sometimes redefine the nature of the task and consequently which of the students had the relevant expertise and could exert a controlling influence on the group's activity. They drew the conclusion that social status and academic expertise, as students perceive and acknowledge them, are relative, interact with each other, and are likely to be negotiated and renegotiated within each group. Students' perceptions of the goals of the group, and of who is more or less able, are the products of group processes as much as their causes.

The data used in this analysis.

The data used in the analysis reported in this paper comes from four of the studies that Adrienne Alton-Lee and I have carried out as part of the Understanding Learning and Teaching Project. Each of the studies consists of a detailed observation and recording of the classroom experiences of selected students during a unit in science or social studies in an upper primary or intermediate school classroom. Details of the content of the units and the students selected for observation are contained in Table 1.

Include Table 1 about here

Details of the students' classroom experiences came from continuous observations (one observer per student), from parallel audio and video recordings, and from interviews with the students. Measures of student learning come from a printed outcome test designed to cover all the learning outcomes intended by the teacher of each unit. This test was administered several weeks before the unit began, several weeks after the unit finished, and again 12 months later. In addition, interviews were carried out with each student in which questions were asked about what the student recalled of their experience during the unit, what answer they gave to each question on the test, why they gave that answer, and whether or not they could recall anything about learning that information, concept or

principle. Further details of these procedures have been reported elsewhere (Nuthall & Alton-Lee, 1993, 1995; Nuthall, 1996).

Analysis of the learning experiences for each student involved creating an item-file for each of the items in the outcome test for each student. Each item-file included the data from observations, recordings and interviews about any student experiences that could have been related in any way to the learning of the content of that item. Predictions about whether the student would or would not learn the content of the item were based on an analysis of the content, nature, sequence, and timing of the relevant experiences. The right hand column in Table 1 reports the number of items for which an item-file was created for each student. The number represents the number of completed test items for which complete data on students experiences (including interview data) was available.

The ability level of each student is represented in Table 1 as an age-related percentile score. This percentile score represents the average of all the age-related percentile scores available for that student. For each of the students there were percentile scores available from school records from at least three of the PAT tests on reading comprehension, listening comprehension, study skills, mathematics, or TOSCA. Reading comprehension scores were available for all the students, but availability of percentile scores on the other tests varied from student to student and school to school.

Predicting student learning.

As a method of assessing the validity of our model of student learning processes, we used the model to develop procedures for predicting, from an analysis of each student's classroom experiences, whether or not the student would learn and remember the content of each of the items in the achievement tests. On average we were able to predict the learning of 85.6% of the items whose content was learned, and predict failure to learn for about 80.3% of the items that were not learned (Nuthall & Alton-Lee, 1993). We also carried out an analysis of why we failed to predict the outcomes for the remaining items. Failure to predict learning occurred when students showed evidence of inferring relevant knowledge from marginally relevant activities or resources, and where the students used resources or engaged in activities that we were unable to observe. Mistakes in predicting failure to learn occurred primarily because of student misconceptions or

misunderstandings. Further analysis of prediction failures has been reported before (Nuthall & Alton-Lee, 1993).

What we have not examined so far in our analyses of the data, is whether the prediction errors were systematically related to student ability. For example, the more able students may have learned more than our model predicted because they required fewer or less complete sets of experiences, or the less able students may learned less than our model predicted because they were more prone to misconceptions or misunderstandings.

The following two figures set out the relationship between student ability (average PAT scores) and the success with which our model predicted test-item content that they did learn and the test-item content that they did not learn.

Include Figures 1 and 2 about here

If there was a relationship between ability and learning, then we should have over-predicted the learning of less able students and under-predicted the learning of more able students. Similarly, we should have under-predicted the failure to learn in less able students and over-predicted the failure to learn in the more able students. In both cases, we should have found a curvilinear relationship between ability and prediction success, with lower prediction rates for both the more able and the less able students. The relationship shown in both Figures 1 and 2 is curvilinear but in the opposite direction. Our lowest prediction rates were for students in the mid-range of ability. There was no indication from this data that the learning process was not the same for both the most able and the least able across the three different studies.

There is, however, a relationship between amount learned and ability. As other research has shown (e.g., Alexander, Kulikovich & Jetton, 1994), there is a clear relationship between measures of academic aptitude and the amount that students learn from classroom experiences. Figure 3 sets out the relationship in the data from four of our studies between the average PAT percentile scores and the amount learned by the students. Amount learned is expressed as the percentage of those items on the achievement

tests that were not known at the beginning of the unit, that were learned during the unit (and in most cases still known 12 months later).

Include Figure 3 about here

Figure 3 shows a clear and systematic relationship between ability and learning. The lower the average PAT percentile, the lower the amount learned. One explanation for this result is that the amount learned is a function of the level of prior knowledge that students bring to their learning experiences and that PAT scores reflect differences in students' prior knowledge. While the learning process might be the same for the more and less able students, what distinguishes them is the greater relevant knowledge that more able students bring to their experiences. Figure 4 sets out the relationship between average PAT percentile scores and levels of prior knowledge, expressed as the percent of outcome test items already known before the unit. Figure 5 sets out the relationship between prior knowledge and the amount learned during the unit.

Include Figures 4 and 5 about here

What this data suggests is that student ability is related to levels of prior knowledge, but that there is no discernible relationship between levels of prior knowledge and amount learned during the unit. On this evidence, the explanation that ability is related to amount learned via differences in prior knowledge seems implausible. However, the lack of a relationship between prior knowledge and amount learned is not what might be expected. It is generally accepted that those who know more learn more. The data in our studies is, however, extremely detailed and specific to the content and focus of particular curriculum units. Exactly how prior knowledge might be related to what students learn, as well as to their ability, is explored later in this paper.

The other explanation for the lack of an apparent relationship between amount learned and ability that seems most consistent with the data and with the evidence from related research is that differences in ability reflect differences in the ways in which students access the opportunities to learn that are available in the classroom. While the learning process is the same

for all students, low ability students are prevented from using opportunities, or do not make use of, or create, as many opportunities, as their more able peers.

This explanation can be explored by comparing the ways in which students engage with the learning opportunities and resources that are available in the classroom. The advantage of our model of learning is that it makes it possible to identify for each student those experiences that are critical to the learning of each of the concepts, ideas, or pieces of information covered in the outcome tests. For each of these experiences for an individual student it is then possible to find out what caused the experience and whether other students in the same classroom shared the same experience. In the remainder of this paper, I will illustrate how this kind of analysis works, and then summarize the results of carrying out the analysis across the data from four of our studies.

Comparative analysis of critical learning experiences: The case of the South Pole.

The following is an example of an analysis of an item-file from Study 6. It illustrates both the nature of the learning process that is described by our model and the differences that emerge in the learning experiences of different students.

Study 6 involved the observation of a Form I class studying a women-focused unit on people working in Antarctica. The unit lasted for 13.4 hours over 6 days and involved a variety of activities, e.g., watching a video on Antarctica, listening to and summarizing talks by two visiting speakers, researching and writing about an Antarctic animal, reading and summarizing articles about women scientists working in Antarctica, playing a card game based on the food-chain in Antarctica, producing a project book recording work done during the unit. The experiences of five students (Jane, Joy, Jim, Paul and Teine) were observed and recorded in detail throughout the unit.

One of the intended outcomes of the unit was a general knowledge of the geography and the location of significant places in Antarctica. One of these places was the South Pole. There were three questions in the outcome test designed to assess the students' knowledge about the location the South

Pole. One was a multiple choice item that included common misconceptions (Antarctica is the place where there is: a. the Meridian, b. the North Pole, c. the Arctic circle, d. the South Pole, or e. I don't know). The second question asked for a list of all the place names the students could remember. (Write down the names of any places that you know in Antarctica: ...). The third question consisted of a blank map of Antarctica with instructions to: Add as much information as you can to make this into a map and put in as many place names as you can.

These questions were answered by the students both before the unit and several weeks after the unit. In addition, students were interviewed about each of these questions a year after the unit. In this interview they were asked to identify their answers, to explain how they answered the questions and to recall any experiences that had come to mind, or helped them to answer the questions.

The results of these three questions and the interviews were collated to determine what each case study student had learned about the existence and location of the South Pole in Antarctica.

Insert Table 2 about here

Jane, Joy and Jim learned and remembered the existence and location of the South Pole during the unit, although there were some variations in their performance. Jim, for example, had considerable difficulty with spelling and avoided writing names wherever he could. Paul already had the appropriate knowledge before the unit, and Teine remained convinced throughout the unit that the North Pole was in Antarctica. She also believed that the Arctic circle was in Antarctica, and drew the Arctic circle on her map apparently in the belief that the words 'Arctic' and 'Antarctic' had similar meanings.

There was no explicit discussion of the geography of Antarctica during the unit. Most place names came up as part of discussions or activities relating to other content. References to the South Pole came up in the video at the beginning of the unit, in discussions between students working in group activities, during whole-class discussions with the teacher, and during the

talks by visiting speakers. The following abbreviated excerpts indicate the general nature of these references:

1. Narrators commentary in the video watched by the whole class early on Day 2: " ... Surprisingly in spite of the extreme cold and six month long winter nights, the sun shines at the South Pole for about as many hours each year as it does at the equator." ...

2. Teacher-led discussion with whole class (What do you know about Antarctica?) later on Day 2.

Teacher: Why wouldn't you need one [compass]? Why wouldn't you? Nevin?

Nevin: Um, cause how can you point south when you're at the South Pole?

Student: North Pole.

Teacher: OK. So where would you be pointing?

Nevin: You would just be pointing up into space.

Student: Pointing to nowhere.

3. Joy and Paul both did a homework activity on Day 3 in which they used an atlas to fill in the names of places on a blank map of Antarctica. Both their completed maps included the location of the South Pole. They later included them in their project booklet (see Figure 6).

Include Figure 6 about here

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4. On Day 5, a woman student came to talk and show slides to the class about the work she had done over the summer in Antarctica. At the end of her talk, the students asked her questions they had prepared beforehand.

Paul: Have you been to the South Pole?

Speaker: No, I didn't go to the South Pole. And the reason for that is because Antarctica is so huge, it takes hours and hours to fly there and they didn't want to waste petrol on us just flying there. Very few people actually get to go there. Yep. ...

The total number of experiences relevant to the South Pole varied from student to student (see Table 3) but our content coding and prediction procedures indicated that each student was involved with a sufficient

number of the appropriate kinds of experiences to have learned that the South Pole is in Antarctica.

Insert Table 3 about here

Because none of the experiences (with the exception of Joy and Paul's use of an atlas during their homework activity) contained an explicit description of the location of the South Pole in Antarctica, the students' learning was based on indirect or partial information. According to our model (see Figure 7) this meant that as each new (South Pole) experience occurred, the students' minds:

(a) integrated this experience with any previous relevant experiences still held in short-term memory, and

(b) deduced from the progressively integrated information obtained through these experiences how this information might be related to existing knowledge and what implications it might have for other knowledge. For example, the series of references to the South Pole embedded in the descriptions of working in Antarctica, that the students heard or read about, were integrated with each other and implied that, for instance, the North Pole is not in Antarctica (a belief that two of the students had before the unit).

Insert Figure 7 about here

As the results in Table 2 indicate, the prediction that each of the students would learn was correct for Jane, Joy and Jim, irrelevant for Paul, and incorrect for Teine. Teine was the least able student among the five selected students, and Paul and Jane were the most able (see Table 1).

The next step in the analysis of the South Pole item file was to identify the occasions when critical learning experiences occurred for each student and whether or not the same learning experiences also occurred at the same time for the other students. The following are four examples of such occasions, with an analysis of why some of the students were engaged in a significant learning experience and others were not.

1. Irrelevant social interactions during learning opportunities.

There were several occasions when Teine became engaged in social interactions with students sitting near her when the other case study students were engaged in a topic-relevant activity. For example, early on Day 2, the teacher asked the students to work in groups and to make a list of questions they would like answered about Antarctica ('Write down a question you have that you would like to find out about Antarctica'). Teine and Leigh and others in their group were writing out their questions individually. Teine was singing to herself ('Do you really want me, baby'), writing, and glancing around at the others.

Teine: Stop using my felts.
Leigh: (inaudible)
Teine: Yeah well Abbie, well Abbie's....'
Leigh: What? (inaudible)
Teine: I know cause she's too shy. Everyone's teasing her about, she likes Colin. Which is, I think is true. Colin?
Leigh: (inaudible)
Teine: Nell, yeah, I know, but that's not true and now she's, she's really ... , etc. (Day 2, time 149 & ff.)

At the same time, Jim and Paul were involved in the same task and were also talking together with those sitting near them.

Koa: Does anybody know anything about why Antarctica's so cold?
Jim: Because of all the ice.
Koa: How did the ice get there?
Jim: Ah ...
Paul: It's at the South Pole because it's the furthest point away from the sun.
Ben: Eh?
Jim: It's the furthest ...
Ben: It's at the Pole
Jim: It's the furtherest.
Ben: It only has the sun for part of the year. It's got big long periods and short periods and so. (Day 2, time 150 & ff.)

On this occasion, Teine, Jim, and Paul were engaged in the same task and talking to their immediate neighbours (Teine in her group, Jim and Paul in their group). Jim and Paul's conversation was focused on topic relevant content. Teine's conversation was about personal relationships with her peers. In Jim and Paul's group, Koa's curiosity about why it is cold in

Antarctica led to a discussion in which Paul shared his prior knowledge with the others in the group and created a critical learning experience for Jim. The question this raises is why do such spontaneous academic discussions arise in some groups in the classroom but not in others?

2. Content discussions stray from the teacher's intended focus.

On a later occasion in the item-file on the South Pole, Teine became involved in a topic-related discussion. However, the content of the discussion was not directly related to the South Pole. The students had been asked to write descriptions and captions for large photographs of scenes in Antarctica. Joy, Jane, and others in their group, were examining a photograph and writing notes about it for their own reports. Joy wrote: 'Why are these people here? They are going on a journey to the South Pole.'

Joy: Jane, are you finished?
(stands and moves around)
Jane: Where do we go to?
Joy: Miss B, what do we do now?
Teacher: Right. If you can just, you can join the next group ... etc.
(Day 2, time 541 & ff.)

Joy's behaviour was strictly within the intended focus of this task. She wrote a caption that referred to the South Pole (and helped consolidate her knowledge about the South Pole), then asked the teacher what she should be doing next. During the same period, Teine and others in her group were looking at another Antarctic photo. What they noticed in their photo was the gender of the people in it.

Teine: It could be w....., men and women.
Maude: (inaudible) or men (inaudible).
Teine: Well, how do you know?'
Maude: Cause you can only see men.
Colin: That was in the old days. They (inaudible).
Maude: That was in the old days. They thought men were the stronger.
Teine: Yeah.
Jill: Which was, well, it was kind of ...
Maude: Like because women were never meant to do this at school.
Girl: Yeah.
Jill: They never even got a chance to (inaudible).
Teine: Women was known as housewives and ... yeah and ...

Jill: Women weren't meant to do anything (inaudible).
Maude: Women do (inaudible) the cooking, the cleaning and ...
Colin: Women do waitressing.
Teine: Or the housework, yeah.
Jill: Not to have a job if they have children ... etc.

While this discussion may have had considerable importance for the development of Teine's beliefs about women and her own status, in this context, at this time, it was irrelevant to the academic purposes of the task in hand. Contrasting this example with the previous example, not all content-related discussions between students are useful for learning the required content. Joy and Jane make limited associations to the photograph, but they are within the intended task purposes. Teine's discussion with her group moved outside this intended academic focus.

The discussions that occur between students when they are working together in groups are largely uncontrolled by the task in hand. The focus of their talk reflects in subtle ways the perceptions that students have of what is relevant and/or significant in the immediate context, and the relative significance in that context of their public (academic) and private (personal relationship) agendas (Kollar, Anderson & Palincsar, 1994).

3. Organizing resources for tasks.

On Day 4 in the Antarctica unit, the students were asked to prepare, and write down, questions that they might ask the next day's visiting speaker. This involved making a rough copy of their questions that was later to be used in writing up their report on the talk and the answers to their questions. The teacher had given instructions about using 'refill' paper for their rough copy of the questions. There was some disorganization in the class as the task began, but the teacher re-established the task focus:

Teacher: Now, some people are being a little bit silly and that's disappointing. These questions - OK - if you are going to do it on rough working paper then you have to also put them in good copy because they're your interview questions that are meant to be included in your booklet.

As the teacher was saying this Paul organized his own paper and pen. Jim could not initially find a piece of paper, but was given one by his neighbour,

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Koa. Teine shuffled through her paper inside her open desk. Half a minute later, a discussion developed in Paul and Jim's group.

Jim: Have you gone to the um, what's that , what's that Pole um, what's that proper Pole called?

Ben: The South Pole.

Jim: No um, the actual....

Ben: Magnetic.

Tilly: Magnetic.

Jim: Ah, the magnetic.

Ben: Pole.

Jim: Pole. I want to ask if she's been there.

Paul: The magnetic pole is not the South Pole.

Jim: Eh?

Paul: The magnetic pole is not the South Pole. It's sort of, the South Pole's over here and the magnetic's over there. ... Something else. Did you know that the Scott/Amundsen Station is at the South Pole?

Ben: Yep.

Paul: Mmm. Right at the very South Pole. But then, then Scott Base is on Scott Island. Or is it at, on the Ross Ice Shelf? ... (Day 4, time 343 & ff.)

At the same time as this discussion occurred, Teine was still getting herself organized. The teacher noticed that she had not yet got any 'refill' paper and walked towards her. Teine stood up from her desk and started to move away.

Teacher: Teine, have you got a piece of paper? Got a piece of paper?

Teine: Oh yeah.

Teine then moved back to her desk and looked through the contents, presumably for paper. Apparently not finding any, she went over to her schoolbag (hanging in the corner of the room) and looked there. She found a 'refill' pad and returned to her desk with it. For a few moments she listened to something her neighbour, Abbie, said and then ticked words on the cover of her refill pad. She opened her desk, turned around to watch the students sitting behind her, and replied to something one of them said:

Teine: Don't worry.

She then wriggled in her chair and started to write slowly in her pad: 'Questions about Antarctica'. As she wrote, she looked around, rubbed her eye and leant her head on her hand. She again listened to something Abbie

was saying (inaudible), fiddled with her pen, and started to write the next sentence ('Describe ...')

During this time, Jim had written a question: 'Have you been to the magnetic South Pole?' and Paul and Ben were discussing further questions:

Ben: I've got 'Have you been to Mt. Erebus?'

Paul: Oh, Mt. Erebus! I was going to ask her that. Nah!

Paul has already written two questions (1. Have you been to Scott Base, 2. Have you been to Mt. Erebus?)

Although Teine's behaviour did not exclude her from any specific learning experience, the fact that she spent more time organizing and preparing her materials meant that there was less time interacting with others in her group during task-relevant activities and fewer possibilities for topic-relevant discussions of the kind that occurred between Paul, Jim and their group.

4. Reinforcing misconceptions.

The teacher provided several opportunities for students to choose alternative activities during the unit on Antarctica. In addition to carrying out their own research on an Antarctic animal, the students could do additional tasks such as filling in a map of Antarctica (which Joy and Paul chose to do), or reporting on other things they had found out. Teine chose to create a Word Finding puzzle using the words about Antarctica the teacher had recorded on the blackboard. On the afternoon of Day 6 the students were given time by the teacher to complete unfinished tasks and complete their project book. Teine used this time to create her puzzle (see Figure 8).

Insert Figure 8 about here

At the beginning of the period, Teine was observed singing to herself and ruling lines for her Word Puzzle.

Teine: I'm doing a word find.

Cory: A what?

Nathan: A word find.

Teine: A word find.

Cory: On Antarctica?

Teine: Just some extra work.

Teine continues singing to herself and ruling lines. A discussion develops with Cory about Teine's sister. Teine continues to rule lines, rub them out and correct them for the next 4 minutes.

Teine (to self): Thank you mother. May I?

She turns around to Maude behind her.

Teine: And you're disturbing me.

Teine keeps working on the lines for a further 2 minutes and then pauses, organizes her pens, and starts to copy words onto her Word Find puzzle from the blackboard.

Teine (to Leigh): You must read minds.

Teine (to self): Oooh. She must read people's minds.

Teine (to Abbie & Leigh): I was about to say "how do you spell zoolologist" (mispronounces) and then she goes "how do you spell it?"

Teine continues copying words from the blackboard for a further 4 minutes, with occasional interactions with others.

Leigh (gesturing to Teine's Word Find): (inaudible) more words than that.

Teine: Oh, is it enough?

Leigh: (inaudible) those words up there.

Colin: Teine, what's that for?

Teine: Word Find.

After a further 5 minutes of copying words from the blackboard, Teine sighs and starts organizing pages of her project book.

Teine (to self): Yeah. I've finished. Thank god. Oh my. Word Find.

At the same time, other students were completing required tasks (e.g. a report on the talk of a visiting speaker), making good copies for their project books and chatting to themselves.

Jim: Want me to tell you a joke? Want me to tell you a joke? Koa.

Koa: OK. I'll tell you a joke. Why is Jim Bolger so fat?'

Jim: Cause he's got a bolger.

Tilly: Because he's ...

Koa: Oh wrong one. Wrong one.

Tilly: (inaudible) why is David Lange so fat? Cause he's (inaudible).

Jim shuffles his chair in and kicks Koa under the desk.

Koa: Ow!

Paul: There's a really rude joke which I'm not going to tell you. It's about Parliament but I'm not going to tell you the rude one.

This banter continues spasmodically as the students work on their project books. Occasionally it focuses on their work. For example, Paul watches Ben adding to a picture of penguins in his project book.

Paul: Limbo!

Ben: Oh, they do look like they're in (inaudible).

Paul: Yeah. Look. They do. Everybody limbo!

Jim: Oh! Do that one on your cover.

Ben: Yeah well, what as?

Jim: Swimming.

The differences between the activities of Teine, Jim, and Paul, during this period on the 6th day of the unit are subtle and complex. Teine carried out an activity that was topic-focused and additional to the teacher's requirements. Jim and Paul confined their work more closely to the teacher's requirements. Jim, who had considerable difficulty with spelling, wrote very little in his project book. Much of his time was spent in the kind of banter illustrated above. Teine's Word Finding puzzle helped her to remember a number of the place names in Antarctica but it also contained a number of mistakes, including the term 'North Pole' (see the bottom of Figure 8). Since Teine was one of the students who believed, before the unit, that the North Pole was in Antarctica, this activity helped to sustain this misconception.

Summary of the South Pole item-file analysis.

This analysis of the south Pole item-file illustrates the comparisons that can be made around each student's critical learning experiences. In these comparisons differences were found between the students in the ways they used their time during teacher designed tasks. The following section reports the results of carrying out a systematic comparison of students' experiences in those item files from Study 6 in which the learning outcome for one student had been significantly different from the learning outcomes for the other students. Related data from the other three studies will be included where it helps to illustrate more clearly the differences that seem to emerge.

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Factors affecting differences in students' learning experiences.

1. Differences in background knowledge.

There was a set of item-files in which there appeared to be no differences in the experiences of the five students but there were differences in what they learned from those experiences. Evidence from the interviews for these items suggested, however, that these were occasions when differences in background or related knowledge created the difference in what was learned. The effect, however, was not a simple one. The evidence in Figure 5 above indicates that across the four studies, there was not a direct relationship between level of prior knowledge and amount learned. Instead there appear to have been several different ways in which prior knowledge and beliefs affected learning.

On some occasions it appeared that a student learned from a set of experiences only because they already possessed critical background information. These were occasions when the classroom experiences did not include a critical piece of information. For example, there was a test question in Study 6 that asked for the location of the training camp used for workers going to Antarctica (There is a training camp for people who go to Antarctica at: a. Mt. Cheeseman, b. Mt. Aoraki [Mt. Cook], c. Lake Tekapo, d. the International Antarctic Centre, or e. I don't know). The only reference to this training camp during the unit occurred in the talk by one of the visiting speakers (R). She referred to the name of it in four different contexts, but never made it clear what kind of place it was.

> R: ... we went to a place called Tekapo. We had to learn how to survive 'cause it's a pretty scary place down there and when we were at Tekapo, we stayed there for a week and they taught us heaps of things. (Day 5, times 74, 75) ... when we were at Tekapo they told us it was a very, very big risk (Day 5, time 267) ... And when we were at Tekapo they showed us heaps and heaps of gruesome photos. (Day 5, time 321) ... etc.

Our model does not predict that students will learn and remember an idea from such a small number of instances of incomplete information. In particular, the speaker did not include any description of the place as 'Lake Tekapo' or as a 'training camp'. The tests and interviews indicated that none

of the students did learn this information except Paul. In the interview a year later, he recalled that the speaker (R) had talked about it.

Paul: Ah, Lake Tekapo cause I think that one of them mentioned ... about a training camp. I think that they mentioned Lake Tekapo where it was.

Interviewer: Aha. Do you remember which one?

Paul: Ah, I think it might have been R.

Other evidence indicated that Paul had local knowledge of Lake Tekapo and the army training camp there. Paul must have been able to link the speaker's reference to 'Tekapo' to this prior knowledge, providing him with the additional information needed to make sense of the speaker's description. As a result he learned and remembered both the information and its source a year later.

This is an example of the way in which background knowledge is normally expected to affect learning. Students with relevant background knowledge have an advantage over students who do not. Arguments about the 'cultural capital' of middle class students usually support such a view. However, background knowledge can also have the opposite effect. Because of the way existing knowledge and beliefs are used to interpret and understand new information, when they include misconceptions, or alternative conceptions from those that structure the intended content, relevant experiences during a unit can be misinterpreted.

During the unit on Antarctica, the students were expected to learn that the strong winds, that were frequent in Antarctica, caused snow to pile up around buildings. The test-item asked: The snow that piles up high around the huts in Antarctica is there because a. it is blown there by high winds, b. the scientists heap it up there, c. there is always a lot of snow falling, d. the snow sticks to the metal walls, or e. I don't know. During the unit there were several references to the severity of winds and snow storms, and there were several pictures the students saw of snow piled up around buildings. There were also references to the need to clear the snow from around buildings at the end of the winter and after a blizzard. There was never any explicit connection made between the snow piled around buildings and the high winds. However, as our model suggests, students' minds normally integrate related information and deduce the implications of that information. In this example, all the related information was provided and

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the model predicts that the students would learn and remember the answer to the question. As Paul reported in his interview:

Paul: Oh, it's very windy and it blows a lot of snow around so it probably would pile up high around the huts in Antarctica.

Interviewer: Have you got any pictures in your mind or did you read about it?

Paul: Um, yeah. Actually I can remember seeing snow piled up around some huts.

However, Joy did not learn this information. As she reported in her interview:

Joy: Um, I thought it might heap it up so that the huts wouldn't fall down.

Two factors affected Joy's learning. First, she was sure in her answer on the pre-test that snow piled up around buildings because 'the scientists heap it up there'. Second, there was a potential ambiguity in the relevant learning experiences. Descriptions of high winds and snow storms were often accompanied by descriptions of the precautions taken to protect huts and tents against the high winds. For example, the first speaker (R) talked of the precautions they took to preserve Shakleton's original hut.

R: (showing slide of Shackleton's Hut) There was also this big cable here that comes off. There's another one over there and those cables are to hold the roof down in case in the winter when they get blizzards, sometimes the wind is really strong and the whole hut might blow away. So they had to cable it down.

The second speaker (M) described the snow piling up around their tents after a blizzard at the same time as she talked about the precautions they took to protect the tents from the blizzards.

M: (showing slide of tents after blizzard) Well, after a blizzard the first thing you have to do is find everything and dig yourself out ... snow blows from other places and blows all around and gathers up ... everything must be tied to everything else ... you must put big rocks down to hold it up ... there's still things buried under here (points to heaped snow) ... etc.

Given Joy's prior belief, information like this could be interpreted as confirming the connections she had already made between high winds, taking precautions, and seeing snow piled around buildings. Without

alternative knowledge structures or information to guide the sorting and integrating of new experiences, students' minds are likely to associate and integrate those experiences that simply occur together. In this example, Joy's background knowledge supported creating connections between contiguously experienced information.

The process of making connections between new information and existing knowledge depends on students having underlying knowledge structures that facilitate certain kinds of associations and inhibit others. As several researchers have suggested, an important part of school learning is the acquisition of the 'genres' or ways of speaking and thinking that constitute the different academic content areas (cf. Green & Dixon,1993; Wells, 1994). Embedded within these genres are expectations about the kinds of talk, the kinds of evidence, and the kinds of reasoning, that are acceptable. While such genres are not fixed and develop local variations during the histories of the teacher's and students' interactions within each classroom, they are not equally understood by all students. Those, who for a variety of cultural reasons may not fully participate in, or understand, these daily interactions, may have only limited awareness of the underlying linguistic and logical structures. In Study 4 there was an example of the way one student had an alternative understanding of the kinds of experience that have priority in a science topic. When Tui was asked, in an interview, what made a rainbow, he explained:

Tui: I was talking about it before, like the sun on the rain makes rainbow, it sort of mixes in, that's how all colours come out or something.

When the interviewer went on to ask how he had learned this, Tui referred to his own private experiences.

Interviewer: How did you learn that Tui?

Tui: Well Mum used to talk about sun showers and that about under the rainbow ... what's that mean and she would say sun on the rainbow.

Interviewer: Did it come up during class?

Tui: Yep

Interviewer: Tell me about that

Tui: Well some days when I am at school it's not so hot or not so cold, just warm and then we see this rainbow pop up.

Interviewer: And did people discuss it?

Tui: Well we just look at it and get on with our work.

For Tui, the phrase 'coming up in class' was interpreted as a reference to personal experience in class, not to the teacher-initiated classroom activities that the interviewer intended. Tui's conception of the classroom and what mattered in the classroom seems to have given priority to essentially private experiences rather than those that the teacher would have considered significant.

Making connections between academic content and personal experience is usually encouraged and seen as an important aspect of effective school learning. But there are cultural boundaries around the kinds of personal experiences that are thought to be appropriate and useful. When Teine was asked in the interview 12 months after the unit on Antarctica why the snow piled up around buildings she said it was because snow sticks to metal surfaces.

Teine: Cause I put my finger on the fridge (and it stuck).
Interviewer: Oh. OK. Have you done that?
Teine: Yep.
Interviewer: That could be painful.
Teine: Mm. But it wasn't.

Such private experience can enhance classroom learning. Paul's knowledge of Lake Tekapo provided him with the key to learning and remembering relevant information about the Antarctic training camp. But students need to know that when private experiences compete with academic classroom experiences the classroom experiences should be given priority. This requires them to know what counts as academic classroom experience, and to have developed an understanding of the hierarchy of alternative experiences and sources of knowledge.

This analysis of our data suggests that differences in background knowledge do account for differences in what students learn from their classroom experiences, but that these differences are not simply a function of the amount of relevant background knowledge that students possess. Prior knowledge and beliefs can interfere with learning when they contain misconceptions or alternative conceptions. Making the appropriate associations between background knowledge and new experiences depends on already possessing those underlying knowledge structures that make up the genres of the different curriculum areas.

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Understanding the requirements of academic tasks

There are many situations in which students have to make choices about how best to spend their time in the classroom. Even in tightly structured programmes there may, for example, be times when tasks have to be completed within insufficient time limits. Students must make choices about what aspects of a task can be omitted or completed less carefully. Making these choices depends on the students' understanding of what the teacher values or expects from them. In one of the examples given above, Teine decided to spend her time on the final day of the unit creating a Word Finding puzzle instead of completing her project book. Her choice was guided by her sense of what would improve her project most. As it turned out, the Word Finding puzzle became the occasion for reinforcing one of her misconceptions (the North Pole is in Antarctica).

In Study 4, there was an example of a student making a similar choice. The unit was a study of the weather, and Tui decided on the first day that he should produce a neatly written project report. The teacher had not asked for this, but Tui gave the impression that he was doing it to improve his work on the weather. Tui's decision meant that he had to find additional time during the unit to create this report.

During the second period of the weather unit, the teacher gave instructions to the students about keeping a daily record of the weather, and about using the instruments needed to make this record. The teacher then demonstrated and talked about how to use a compass to tell the direction of the wind. Tui took this opportunity to start the cover page of his project report. As the teacher discussed the compass, Tui started drawing a large coloured heading ('About The Weather') on his cover page. He ignored the compass discussion and tried to engage the students sitting next to him in an alternative conversation in which he assumed the authority of knowing what was required:

> Tui: I'm doing my project now. We're starting it today. ... (continues to write on his cover sheet) ... How do you spell 'about the weather'? (continues writing and organizing different coloured pens)

As a result of missing the class discussion, Tui continued to believe that the direction of a compass needle was determined by the wind, and that wind direction was described by where the wind was going to and not where it

was coming from. When the teacher later asked the class, 'What good is the compass going to be to us?', Tui whispered to himself, 'Nothing!'

Understanding the requirements of academic tasks is especially critical when the teacher's instructions are ambiguous or assume that the students understand what is implied rather than stated. Implicit understandings are common in classrooms. Each classroom becomes a language community in which meanings and ways of referring to them are built up during the history of the teacher's and students' interactions with each other (see for example, Brilliant-Mills, 1993; Floriani, 1993). The following is an abbreviated extract from the teacher's instructions to the students at the beginning of the unit on Antarctica.

Teacher: Okay. Shhhh. Right listening very carefully. Once you get this sheet, I'd like you just to read through it quietly ... and then we'll discuss it and I'll tell you what I expect. Your expectations. Okay? ...

Student: Is this a type of project?

Teacher: It is sort of like a project. Thank you Kurt. Okay. Right. ...

Maude: Um, what book, are we going to do it in?

Teacher: Okay. Um, it expect it, ... I expect it to be done on refill paper. ...Okay? I expect it to be your own work. Now that's very important. I don't want to read bits of the Encyclopaedia Britannica or the Greenpeace book on animals. Alright? I want to hear what you know and what you can tell me. Right?

Leigh: Can we do it in our social studies books?

Teacher: No. Right. The reason it's to be done on refill paper is that, every day next week you must be prepared to show me what you have done. Because if you carry on and I don't check up what you've done it will come to Thursday night and you'll spend probably five or eight hours, cram packing what you haven't done. I know that's how some people work. Okay. So every day you need to bring it to school, to work on. Kurt?

Kurt: Are we allowed to read the Greenpeace, Greenpeace books and stuff and then put our own words there?

Teacher: That's what's called paraphrasing. That's fine. Okay?

Leigh: How long does each section have to be?

Teacher: You have to um, make that decision. I want quality not quantity okay and I want quality in your own words. Alright. Okay.

These instructions contain a number of significant words (project, refill paper, social studies books, paraphrasing, quality, quantity, cram packing what you haven't done, etc.) that students must decode in order to know what the teacher wants them to do. The history of the use of these words in this class will guide the students interpretation of these words, but not all students will have shared in the activities that helped define their specific meanings. Those who fail to acquire the implicit understandings that characterize the language of a classroom are those who do not share the cultural understandings and background of the teacher and the majority of the students. They may end up working hard, as Tui and Teine did, but the work is directed at ends that are not valued by the teacher, or it results in critical learning experiences being missed.

It has also been noted by several researchers (cf. Anderson, 1984) that teachers do not routinely explain the academic or intellectual purposes of classroom activities. Why students are expected to carry out the requirements of specific tasks is often left implicit or is only briefly or vaguely described. Instead, the practical and surface features of tasks are explained and specified in detail. The teacher in Study 6 did not intend to do this, but her written instructions to the class emphasize what needs to be done at the expense of the purpose for doing the tasks (see Figure 9).

Insert Figures 9 and 10 about here

The consequence for a student like Teine was her inability to describe the purpose of the unit on Antarctica (see Figure 10). Her question marks express her lack of any sense of what the teacher intended her to learn through the unit. Paul, on the other hand, answered the same question with: 'To learn what Antarctica is like'. Whether or not Paul understood the teacher's real intentions, he was able to use the language appropriate to describing educational purposes.

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Negotiating the social context of the classroom

Social interactions between students occur in almost all classrooms, and are especially critical in classrooms where teachers make use of small group and individual activities. Students need to acquire appropriate social skills if they are to manage their involvement with other students within both formal and informal settings. Problems arise when students must also learn to work together on academic tasks. Even when teachers train their students to interact co-operatively and to maintain an academic focus, there are differences in the ways students manage their relationships with other students within their groups. Kollar, Anderson and Palincsar have described this as the conflicts and interactions that occur between the students' implicit and explicit agendas. (Kollar, Anderson & Palincsar, 1994). Inevitably the ways in which students negotiate and manage their private and public relationships affect their access to, and use of, learning opportunities.

Evidence from an analysis of students' learning experiences in our data suggests that classrooms may contain several social networks that operate within their own social cultures. Two of the types of evidence that led to this conclusion are the existence of note-passing routines, and of different social relationships between students of different levels of ability.

1. Note-passing routines

Some students engaged relatively frequently in writing and passing notes to other students as a way of communicating without the teacher's knowledge. Other students were never observed engaging in this behaviour.

In Study 6 one group of students was observed writing and reading notes on several occasions. For example, during the video on Antarctica on the first morning of the unit, Leigh, Abbie and Teine spent considerable time passing notes to each other. The observer recorded:

> Teine receives note from Leigh, reads note. Teine writes on note and passes note to Abbie. Teine taps pen on desk, waiting for Abbie to read note, glances at Leigh and smiles. Teine tears up a piece of paper to use as a note and writes on it. She passes this note to Abbie via Leigh. (Day 2, times 163-169)

Two minutes later the observer recorded:

> Teine writes on note, glances around. She leans her head on her arm on her desk, and continues writing on note. Teine looks at teacher and hides her note under pad. She sighs and gives the note to Leigh. (Day 2, times 175-180)

A minute later the observer recorded that Leigh whispered Teine's name and passed her a note. Teine read the note and started talking softly to Leigh.

Teine: Why, what do you ...

Leigh: Pride. Is that the way you think she's going to act? Just try to be mature about this.

Teine: Yeah I know but if she wants John - I mean she never acts as if she wants him. You know, like I was ... (gestures with hand)

Leigh: (inaudible) written all over her pencil case.

Teine: Yeah I know, but she doesn't act it does she?

Teine turns to watch video.

Leigh: She's not a (inaudible) person.

Teine: Yeah, I know that but ...

Teine turns again to watch video. (Day 2, times 184, 185)

Note passing of this kind was also observed between students in Study 4. The content of the notes was only occasionally observed, but appeared to be mostly about girlfriends and boyfriends and secret after-school activities. Occasionally the note passing turned into whispered conversations, as the excitement or involvement increased (as in the above example). Although the evidence is incomplete, it suggests the students who engaged in note-passing routines were maintaining relationships different from, and parallel to their more public classroom relationships. Although several of the students showed considerable skill at sustaining interactions at both their public and private worlds simultaneously, it was clear that they did miss critical learning opportunities. Teine, for example, never learned about how the seasons and the length of day were connected in Antarctica because of the information she missed during the note-passing sequence illustrated above.

2. Quality of interpersonal relationships.

The second type of evidence relates to the quality of the personal relationships that occurred between students who were classified as having lower ability. Jones and Carter (1994) noted that there was a greater tendency for conflicts to arise between low ability students (see the quotation cited above). Our own data contains numerous examples of conflict between students working together. Of special concern are the conflicts in which a student undermines the status of another by disparaging that student's ideas, beliefs, or academic status.

There are several examples described above when spontaneous topic-focused discussions developed between students as they worked together on set tasks (cf. Jim, Ben and Paul discussing the magnetic south pole). Often these were critical learning experiences for one of the students. In the next example, Paul changed his mind about the lack of rain in Antarctica. Paul's group was studying a photograph of people working with instruments on the snow in Antarctica.

Maude: Studying weather, yeah.
Paul: But this could be rainfall, rainfall for the week.
Koa: Huh?
Paul: Could be rainfall for the week.
Koa: Could be.
Maude: How do you know rain falls?.
Joy: I didn't know rain falls in Antarctica.
Paul: Rain does fall in Antarctica.
Maude: Amazing!
Paul: That's what turns this into ice (gestures to photo) It's so cool.
Koa: I thought, I thought, I thought it was dry.
Paul: So it still has a bit of rain.

Paul reported in a later interview, 'Oh, the rain almost never falls, but there's snowstorms'.

Such discussions depend on students valuing each other's ideas, and are less likely to occur when students are critical of each other's contributions and abilities. Having the reputation of being a less able student seemed to increase the likelihood of such criticism. In Study 4, Pam was frequently in conflict with other members of her group. On the first day of the unit on the weather, the teacher asked each group to write out all the words they could

think of that were related to the weather. Pam declared to her group that she would do the writing.

Pam: I'm writing. I'm writing. I'm writing. Thank you.
Thomas: (inaudible)
Pam: I do not! ... (writing 'compass' on sheet) I'm going to have to put this. Don't look.
Kate: She can't spell.
Pam: Oh, shut up!
Thomas: It's a bit hard when she doesn't know how to spell.
Pam: Hang on. Is it o - u - s?
Thomas: I don't know.
Pam: o - s.
Kate: Hurry up. We've only got five minutes.
Pam: I can't spell 'compass'. Oh, too bad!
Kate: Hurricane.
Pam: Um. Be quiet, just wait! I'm not that fast at writing.
Kate: I am.
Pam: So?
Thomas: Storm.
Kate: Hurricane, rain.
Pam: Just wait.
Kate: Are you doing your boyfriend's first?
Pam: No. I'm not going to put it down 'cause you won't wait.
Kate: Oh, let me do it.
Pam: No! (Day 1, times 4-13)

In Study 6, Teine was both the instigator and the victim of such criticism.

Nathan: So much for your brilliant spelling, Teine.
Teine: So much for your wimping!
Nathan: (abusive comment)
Teine: Oh shut up! (Day 5, times 571-572)

Earlier, Teine had herself criticised one of her group for the way he replied to a teacher's question. As he spoke, she said to herself: 'Oh ... dick! Stupid idiot!' She glanced around, laughed to herself, 'Doesn't even know!' It is not clear whether the other student heard her comment or not.

These critical exchanges between low ability students appear to focus on status and ability. They are quick to criticize each other's academic contributions even though the evidence suggests that they are not as aware

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as high ability students of the requirements of academic tasks. It is as though their own uncertainty produces a social climate of criticism and ridicule in which it is not safe to display any academic competence or knowledge.

Tentative conclusions

The analysis presented in this paper is not yet complete. It lacks a systematic detailing and counting across the four studies of all those occasions when significant differences occurred between the learning experiences of different students within the same item-files. In other words, it is not yet possible to claim that all relevant differences have been identified, nor whether all the differences described are equally frequent. However, some general conclusions are still possible.

The most important finding is what is not included in this analysis. There is no evidence that some students need more relevant experiences than other students in order to learn. The model of the learning process that we have developed does not obscure the fact, within the errors in the prediction of learning, that lower ability students need to engage with more relevant experiences than do more able students. If the appropriate number of learning experiences occur, without significant gaps between them, learning occurs regardless of the ability level of the students.

Similarly, there was no evidence, in the data analyzed in this paper, of lack of understanding of classroom tasks by low ability students, nor of materials being too difficult. Both high ability students and low ability students learned some of the concepts and beliefs, and failed to learn others, because they did or did not experience relevant learning opportunities, not because they differed in their ability to understand.

What then lies behind the fact that different students learn different things within the same classroom, and that the more able students (as defined by average age-related percentile scores on PAT tests) learn more than less able students?

There is evidence that background knowledge makes a difference. But it is not a simple relationship in which the more background knowledge a student has, the more they learn. Different kinds of background knowledge have different effects on learning. There is an interaction between the

nature of the learning experiences available to students and the types of background knowledge they can bring to bear on those experiences. Some background knowledge facilitates the use of classroom experiences. Other background knowledge may facilitate misunderstandings. Any use of background knowledge depends on the underlying knowledge structures that determine how students' minds create associations between experiences.

An important cause of differences between what students within the same classroom learn is the way in which they access or create learning opportunities. For example, academically relevant discussions are more likely to arise between some groups of students than between others. They are more likely to occur when there is a social climate within the group of acceptance and valuing of each other's ideas. This is more likely to occur among more able students than among less able students.

The major factors affecting whether students access or create learning opportunities all appear, in one way or another, to be related to culture. Several stands of evidence suggest that students operate within several different cultures in the classroom. Some students operate within a culture that is close to the academic culture promoted and understood by the teacher. They are the students who believe they know what is going on, they know what is expected of them. They can handle the ambiguities of classroom life with certainty, and know in what ways they need to expend effort to be treated as successful. They are confident and feel at home within the language of the classroom. Their minds process experiences by creating associations, drawing implications, and identifying reasons within the linguistic and logical structures that constitute the genres of the teacher's classroom culture.

Other students live within other cultures. They attempt to translate the meanings and implicit assumptions of the teacher's culture that they must understand in order to do the work that is expected of them. In venturing across from their own to the teacher's culture, they make mistakes that they only partially understand. The teacher's classroom culture is sensed as dangerous ground where they, and others who share their position, are likely to be viewed as ignorant or slow. In trying to sustain the safety of their own subcultures within the classroom, they must spend time on their social relationships, passing notes and carrying on secret conversations. When the

occasion arises, they criticize their own kind for the implicit betrayal involved in being 'smart' in the teacher's culture. They can have little confidence in their ability to succeed in this foreign territory.

There is not space in this paper to develop all the implications of this interpretation of the data, nor to provide the kind of tightly argued case that such a general conclusion warrants. Part of this case I have argued elsewhere (Nuthall, 1996). I am increasingly convinced that what we have come to understand as differences in ability are the product, not of differences in the ways the minds of students process and learn from their experiences, but of the cultural partitioning of students lives within the classroom. It is the ability of students to make use of, and create, learning opportunities in classrooms that determines what they learn. And that ability relates to the difficulties students have living and translating between those deep knowledge structures and beliefs that constitute the teacher's classroom culture and the deep knowledge structures and beliefs that constitute their own culture.

The claim made in this paper is consistent with the claims being made by those researchers who have been examining the relationships between class levels, age within class level, and the distribution of academic ability test scores (Cahan & Cohen, 1989; Oakes, 1992; McDonald, 1996). Evidence is mounting in those studies that what we commonly refer to as academic ability is closely related to streaming and promotion practices and to the way the curriculum is organized, and not to some underlying genetically determined set of aptitudes or abilities.

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Table 1.
Characteristics of the units and the individual students observed and interviewed

Topic of unit and hours of recorded time per student	Students (gender)	Age (years)	Achievement (percentile)[a]	Interviewed after: 1 week	Interviewed after: 12 months	Item files
Study 2. The Middle Ages in England (52.4 hours over 21 days).	Amy (f)	9.9	93	√	√	100
	Kim (m)	9.8	30	√	√	99
	Sam (m)	9.6	14	√	√	97
Study 3. New York: A study of cultural differences (6.4 hours over 5 days).	Ann (f)	12.5	55		√	82
	Mia (f)	12.4	96		√	83
	Jon (m)	11.8	97		√	81
	Joe (m)	12.2	55		√	77
Study 4. Weather: observation and forecasting. (7.1 hours over 8 days).	Rata (f)	10.4	68	√		64
	Pam (f)	10.4	21	√	√	68
	Jan (f)	10.4	70	√	√	59
	Tui (m)	10.4	11	√	√	58
Study 6. Antarctica: Conditions, people, animals, and plants. (13.4 hours over 6 days)	Paul (m)	12.2	89		√	261
	Jane (f)	11.5	83		√	258
	Joy (f)	11.10	70		√	267
	Jim (m)	11.9	56		√	255
	Teine (f)	11.4	34		√	230

[a] Average age-related percentile on at least 3 school school-adminstered PAT tests, including reading comprehension.

Table 2 Learning outcomes of items on the South Pole.

	Pretest			Post-test			Interviews		
	MC	List	Map	MC	List	Map	MC	List	Map
Jane	Arctic circle	o	Arctic cross	Arctic circle	√	√	√	√	√
Joy	North pole	North pole	√	√	√	√	√	√	√
Jim	Arctic circle	o	o	√	o	o	√	o	o
Paul	√	√	√	√	√	√	√	√	√
Teine	North pole	North pole	North pole	Arctic circle	North pole	o	Arctic circle	√	Arctic circle

Key: o omitted answer
√ correct answer

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Table 3 Duration of content-relevant experiences for each student for the items on the South Pole.

	Number of quarter-minute intervals
Jane	36
Joy	45
Jim	64
Paul	55
Teine	27

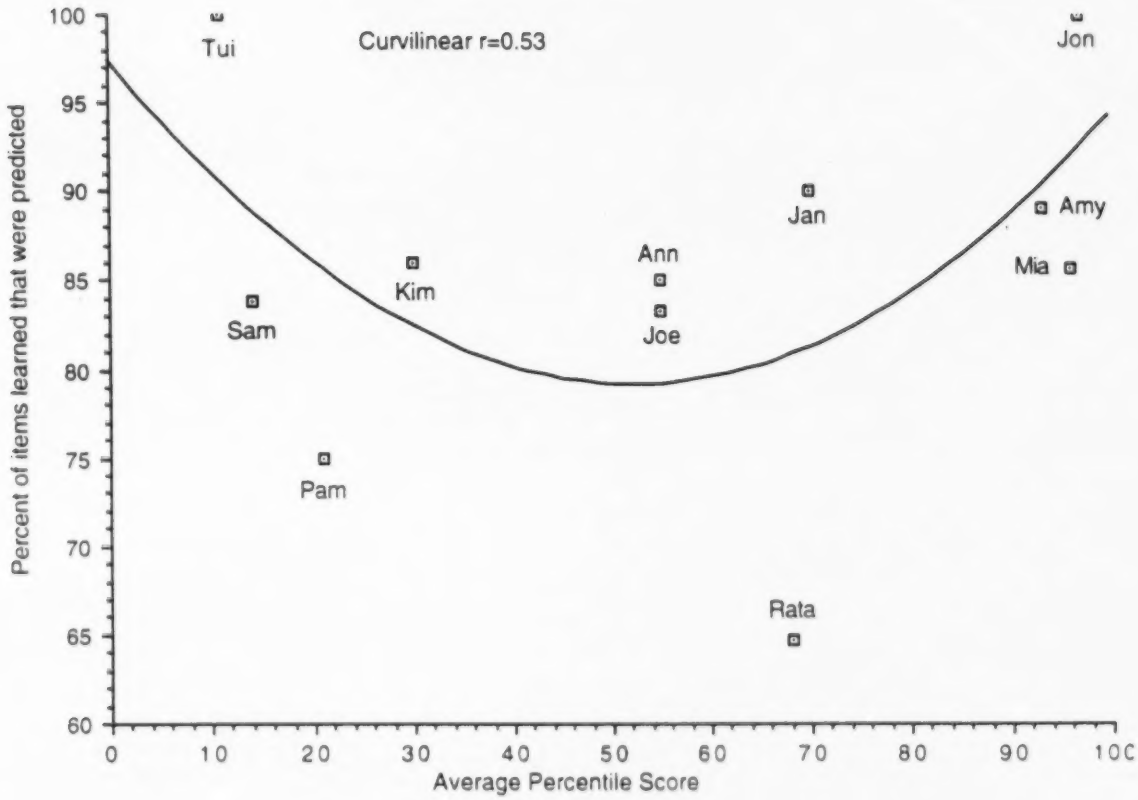

Figure 1. Relationship between percentile scores on PAT tests and prediction of achievement test items that were learned.

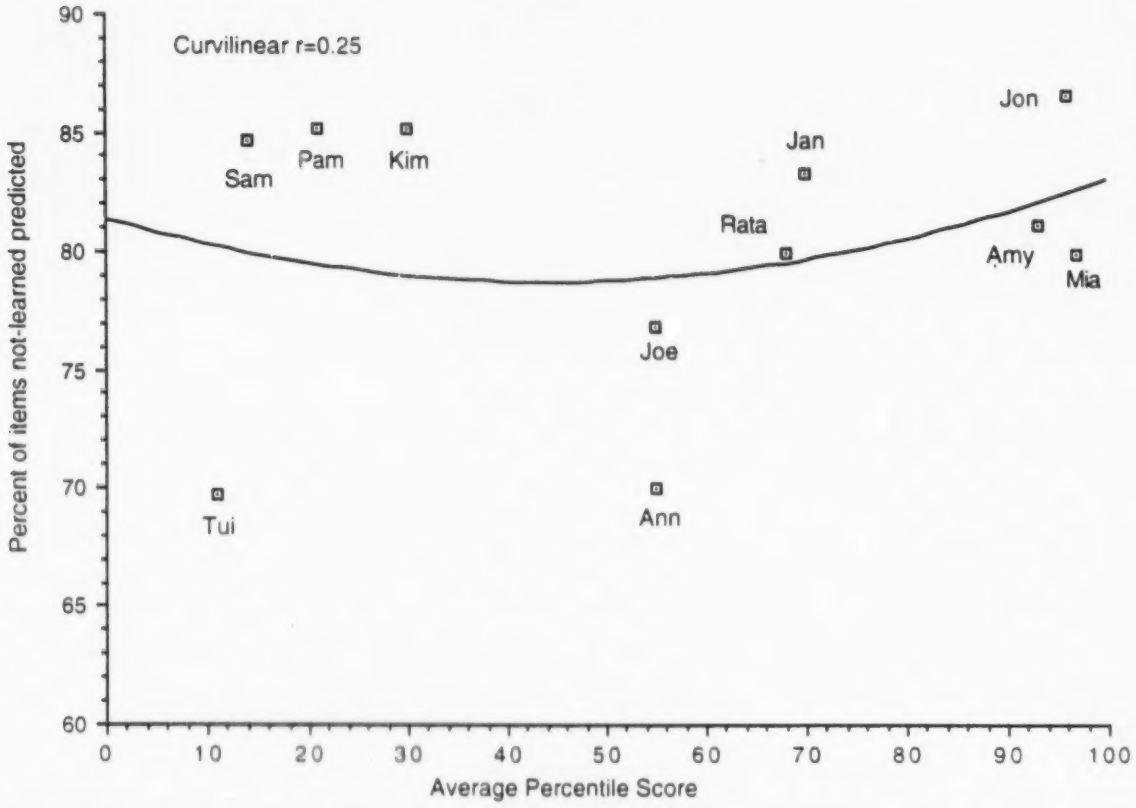

Figure 2. Relationship between percentile scores on PAT tests and prediction of achievement test items that were not learned.

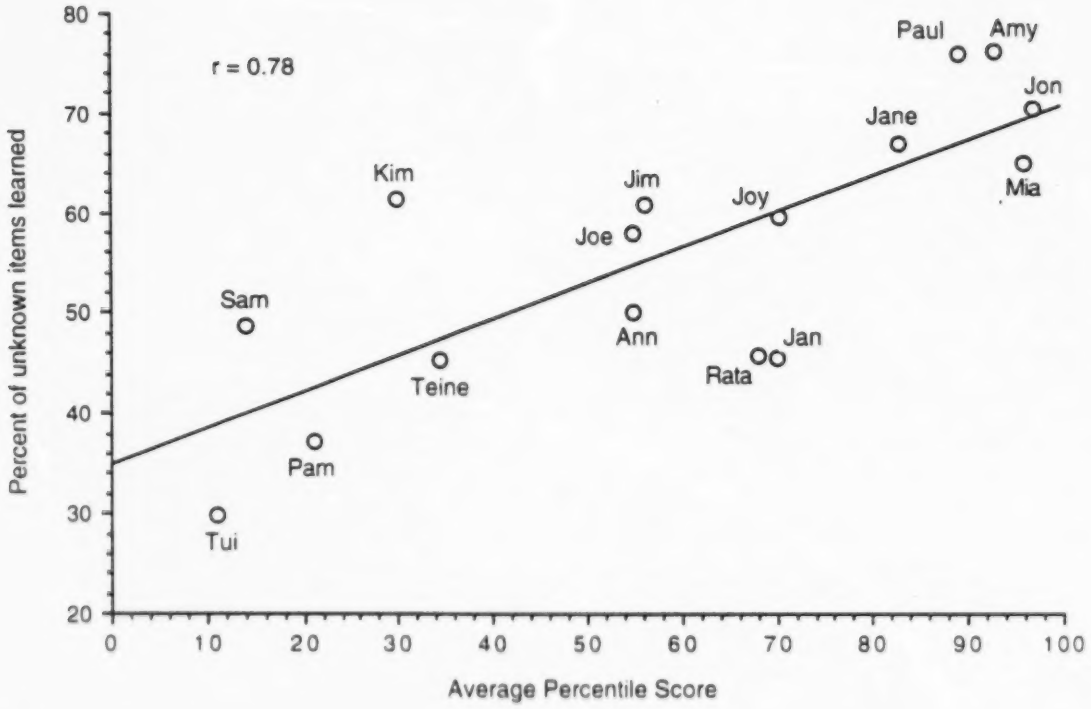

Figure 3. The relationship between between percentile scores on PAT tests and percent of unknown items learned.

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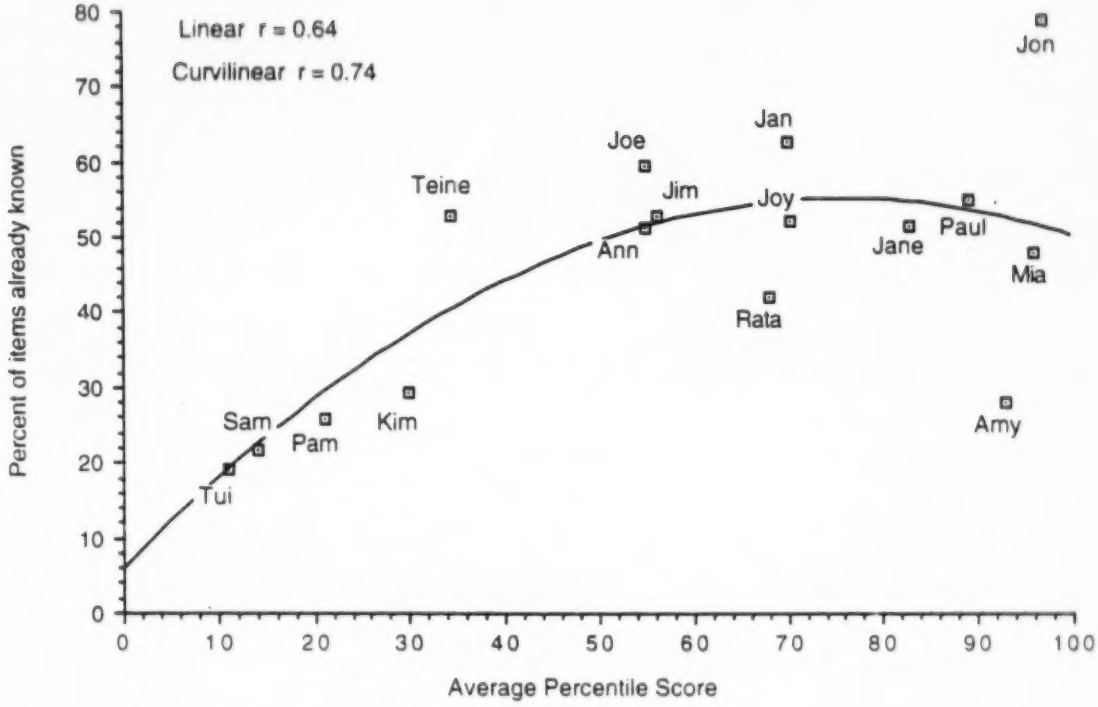

Figure 4. The relationship between between percentile scores on PAT tests and the percent of achievement test items already known prior to the unit.

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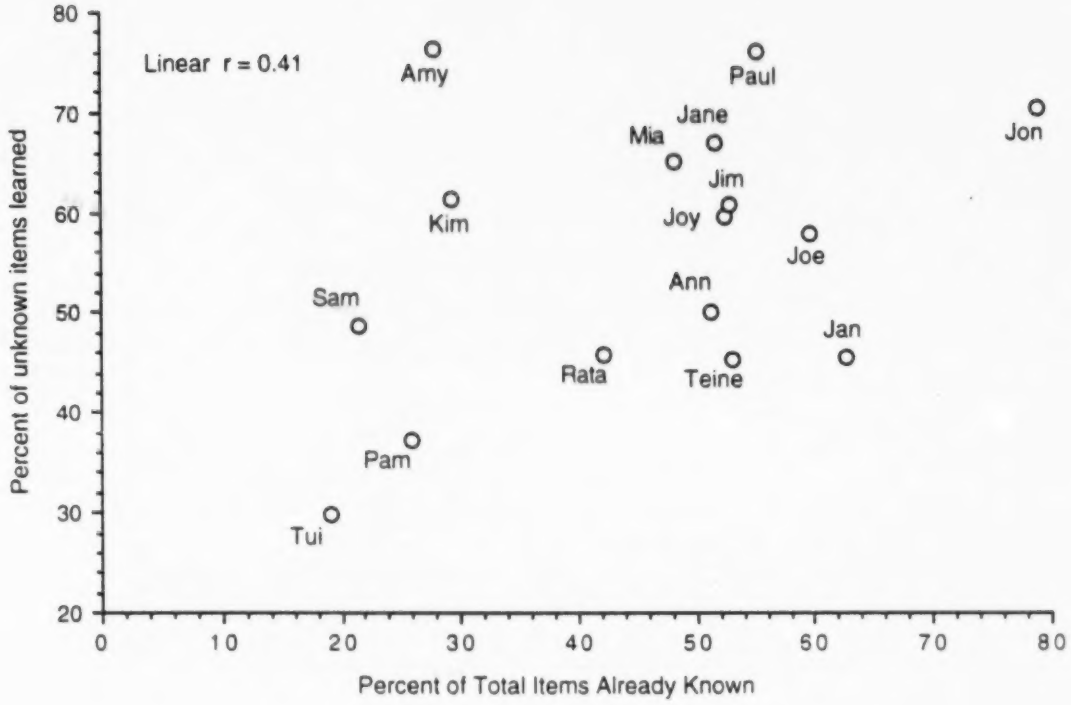

Figure 5. The relationship of achievement test items already known prior to the unit and percent of unknown items learned during the unit.

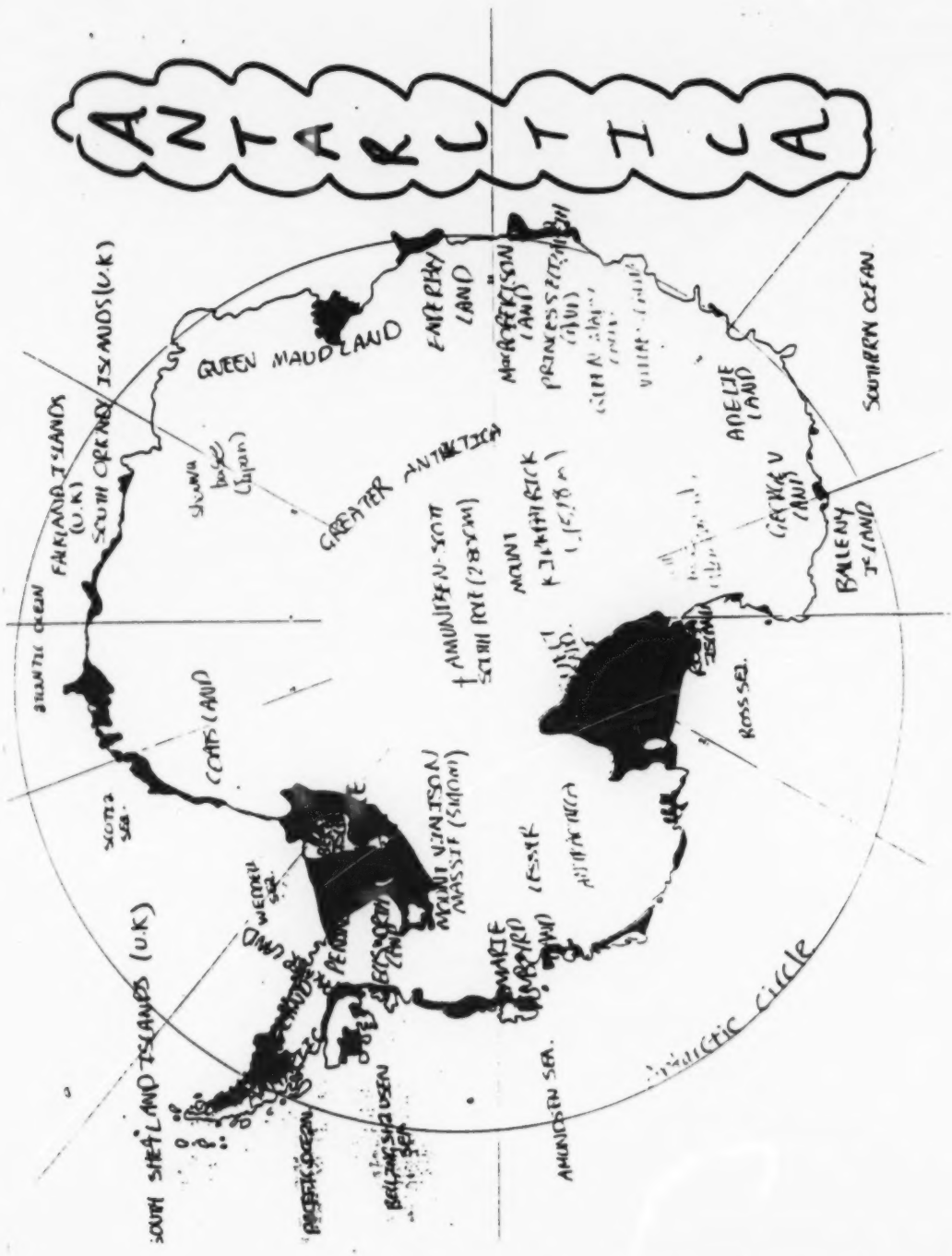

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Figure 6. The map of Antarctica that Joy completed for homework.

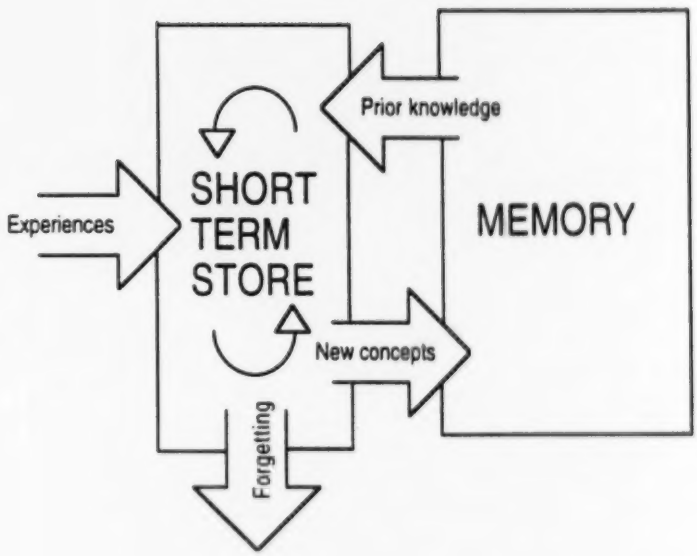

Figure 7. The use the short term store for connecting prior knowledge to new experience.

Figure 8. The Word Finding puzzle that Teine created on Day 6.

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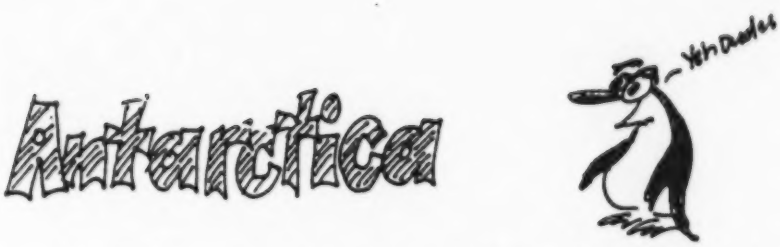

Why do people think feel and act the way they do when living and working in a harsh environment.

This week we are studying this topic. There are several tasks you are required to complete. Use the checklist below and tick of each task as you do it.

All work is to be done on lined refill and made into a booklet. This will have to be ready to be handed in

- ☐ Title page
- ☐ Contents
- ☐ Map/s
- ☐ Picture Interpretation
- ☐ Slide Interpretation
- ☐ Reading Exercise
- ☐ Interview - No. 1 Questions
- ☐ Interview - No 1 Report
- ☐ Interview - No. 2 Questions
- ☐ Interview - No. 2 Report
- ☐ What I know/what I have learnt
- ☐ Bibliography
- ☐ Extra work
- ☐ Individual Research (Antarctic Animal)

Figure 9. The instruction sheet given to the students in Study 6.

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40. What is the most important thing you learned about Antarctica

all of it was ok but Rachel's Hamlins Interview was quite a cool Interview about Antarctica

41. Why do you think Ms wanted you to study Antarctic ?

? ? ? ? ? ? ? ? ?

THANK YOU FOR WORKING SO HARD ON TH S TEST!

Figure 10. Teine's response to the question about the purpose of the unit on Antarctica

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